weather changes, which we follow from day to day by observation and the use of the daily weather map. In my course in meteorology we use Davis as a text-book, which is supplemented by Hann and other references, together with lectures and such explanations as are needed. Now that we have the apparatus, we expect to keep up a systematic record of weather changes. From the data thus supplied blank maps are filled out and completed. Especial emphasis is laid upon the climate of different regions, a subject which is treated of in the course in geography, following the course in meteorology. The MONTHLY WEATHER REVIEW is used daily for reference.

As many libraries, high schools, colleges, and universities, as well as individuals engaged in teaching meteorology, desire to obtain Bartholomew's Atlas of Meteorology, which is in itself a library of information, we take pleasure in communicating the information contained in a letter just received from the American agents:

The Atlas is published at $17.50 net. If any copies are desired for educational institutions or for free public libraries, we can allow a discount of 25 per cent from this price, that being the duty paid to the Government. When the book is to be used in an institution of this kind, all that is necessary is to make an affidavit that it is to be used for educational purposes.

As the atlas weighs a little over 9 pounds, the purchaser can easily estimate the cost of carriage from Philadelphia. In general it can be sent by express cheaper than by mail.

OSCILLATIONS OF TEMPERATURE AT ANY ALTITUDE.

A correspondent recently asked what is known as to the variation of temperature at considerable altitudes above the earth's surface. D. Arthur Berson, the well-known aeronaut, suggested in 1894 that the variation in temperature at any altitude is connected with the variation at the earth's surface by a simple exponential formula, where e is the basis of natural logarithms and h is the altitude in meters;

$$\Delta t_h = \Delta t_0 \, e^{\frac{-h}{1000}}.$$

According to this, if the variation whether diurnal or accidental, is 1° at the earth's surface its amount at other altitudes will be as in the accompanying table:

Altitude.	Variation.	Altitude.	Variation.
Meters.	°	*Meters.*	°
0	1.000	1500	0.223
500	0.607	1600	0.202
600	0.549	1700	0.183
700	0.497	1800	0.165
800	0.449	1900	0.150
900	0.407	2000	0.135
1000	0.368	2250	0.105
1100	0.333	2500	0.082
1200	0.301	3000	0.050
1300	0.272	4000	0.018
1400	0.247	5000	0.007

In his report on the results of recent aeronautic work,[1] Dr. Berson remarks that the formula seems still to hold good but will of course need some slight revision when we have collected a large number of observations at great altitudes.

A WATERSPOUT.

Dr. H. A. Alford of Dominica, W. I., under date of August 25, on the steamship *Fontabelle*, communicates the following:

On the 20th instant, at 7:30 a. m., a very large waterspout, from 600 to 700 feet in diameter at the base, was seen ahead of this ship in latitude 38° 26′ north and longitude 72° 55′ west as kindly determined for me by Captain Mann, and I forward the particulars to you.

The captain has kindly allowed me to take the following extract from his log, which may be useful:

"August 20, strong south-southeast wind to end of day; steamed south one-half east. August 21, strong south-southwest wind and heavy head sea for whole twenty-four hours; shipping heavy water on deck; steering south; midnight, wind moderated and sea went down."

The following were the positions of the ship at noon on August 20 and 21: August 20, latitude 37° 44′ north; longitude 72° 40′ west. August 21, latitude 34° 26′ north; longitude 70° 56′ west.

I shall be obliged if you will inform me whether the stormy weather we experienced was that of the northern segment of a West Indian hurricane.

The weather map of 8 a. m., August 20, shows a trough of low pressure extending along the entire Atlantic coast, with the lowest barometer in the Maritime Provinces, and a subordinate low area central about New York City. The waterspout observed by Dr. Alford was therefore nearly due southeast of this latter storm center, and consequently in the quadrant where both tornadoes and waterspouts are most frequently observed. It was to this slowly eastward moving area of low pressure, and not to a West Indian hurricane, that the winds and sea experienced by the *Fontabelle* may be ascribed.—ED.

ILLNESS OF MR. CURTIS J. LYONS.

Mr. R. C. Lydecker, under date of July 31, announces that, on account of the serious illness of Mr. Curtis J. Lyons, Territorial Meteorologist for Hawaii, he has been appointed by the Surveyor General as Acting Territorial Meteorologist. Having been a member of Mr. Lyons's family for some years, deeply interested in meteorology, and frequently assisting him in his work, the duties of the office are not new to Mr. Lydecker, who will undoubtedly carry on the work according to the same principles that have guided Mr. Lyons.

LIGHTNING PHENOMENON.

The following from the Cleveland Leader is kindly communicated by Father Odenbach, of Ignatius College, in that city:

Geneva, Ohio, November 19.—A phenomenon was seen in Unionville between 5 and 6 o'clock yesterday afternoon, during the snowstorm. There was a flash of lightning, seeming to emanate from the snow itself, and illuminating surrounding buildings and objects quite brightly. It consisted of two almost simultaneous flashes, one stronger than the other, and of a purple and milky-white color. They were followed by a faint roll of thunder like the approach of a distant storm. Such a freak of nature was known to occur during a snowstorm twenty years or more ago.

THE BAROMETRIC DISTURBANCE IN THE DANISH WEST INDIES, NOVEMBER 22-29, 1903.

We are indebted to Mr. John T. Quinn, F. R. G. S. and Royal Gold Medalist, Inspector of Schools in the Danish West Indies, for an early copy of the St. Croix Avis, published at Christiansted, December 5, 1903, from which we print the following article written by him:

The following account of this great movement, which occupied just one week, namely, from Sunday the 22d to Sunday the 29th of November, is mainly based on notes taken in St. Thomas.

The first hint of the approach of the disturbance was given by the high clouds (cirrus, etc.) on the morning of Sunday the 22d. High clouds (cirro-stratus) had been noted on the 19th and 20th as coming from west-northwest, the wind and lower clouds at the same time moving from northeast. On the 21st, at 7:30 a. m., many narrow bands of cirrus were seen, radiating from the south and curving toward the east. Much cirro-stratus also appeared, and both kinds of clouds were moving from the west; but on Sunday morning there was a remarkable display of high clouds, in regard to which the following note was made at the time: "9:15 a. m. A very beautiful band of cirrus and cirro-stratus, stretching about east and west and nearly overhead, the shaft having many faint feathery radiations all looking east; the shaft pointing west and the band a little spreading, plume-like, toward the east. Could not separate the motion of the cirrus and cirro-stratus, the whole appearing to move together from west by south. The sky showed many cirrus shafts having same direction, and some independent patches of cirro-stratus. In one large and very fine patch, with waved silky fibers springing from it in several directions, there was a quantity of cirro-cumulus, but all (cirrus, cirro-stratus, and cirro-cumulus) seemed to be moving together in the same plane."

Cirrus clouds are known among sailors as "mare's tails," and it is well known that an abundance of such clouds is believed by them to in-

[1] Wissenschaftliche Luftfahrten, Vol. III, p. 120, 1900.

dicate wind, a view which at least seems to be confirmed in the present instance.

The barometer on Sunday, the 22d, gave scarcely any indication of an approaching disturbance. At 8 a. m. it stood at 30.02 (previous day at 7 a. m. 30.03) and at 4 p. m. showed 29.97, the difference being little more than the usual daily fall between these two hours. At 4 p. m., however, we find noted, "much nimbus from east by south, giving rain over the sea." This was the first hint of a change in the wind direction and in the character of the weather.

On the following morning (Monday, 23d) we noted: "4:30 a. m., barometer 29.90," and at daylight, "squally, nimbus, and cumulus from southeast, sky entirely overcast." Barometer at 8 a. m. 29.97. At 5 p. m. we have: "Barometer 29.87, cumulus and nimbus from south-southeast, sky entirely overcast; squally, with stiff breeze from east-southeast."

The next morning (Tuesday, 24th) at 4:20 the barometer had fallen to 29.82 and at 8 a. m. stood at 29.87. A stiff breeze was then blowing from south-southeast. At 9 a. m. we noted "sky one gray sheet, from which a scant rain is falling (there were some heavy showers before dawn this morning. A little nimbus from about south." During the morning the wind went round through south to south-southwest, blowing hard all the time, but fell off in the afternoon after some heavy thunder. At 5:20 p. m. we noted: "Wind from about south-southwest, barometer 29.77." Already from the morning it had become pretty clear that a center of disturbance existed westward of St. Thomas and was moving toward the northeast.

On the morning of Wednesday the 25th we noted "3:25 a. m., barometer 29.73, calm, with a gentle movement of the air from about west." At 6:30 a. m. we have: "nimbus from west by north at moderate speed. Barometer 29.80." "8 a. m., barometer 29.82, low clouds from west-northwest." These last entries show that the center of the disturbance had passed to the north of St. Thomas during Tuesday night or early on Wednesday morning, moving eastward (say to about east-northeast). At 5 p. m. the barometer stood at 29.82, therefore 0.05 higher than on the corresponding hour on the previous day. Hence the storm was receding. From Thursday to Saturday calm weather and gentle breezes from the west prevailed, the barometer gradually rising; at 8 a. m. on Saturday it stood at 29.90 and at 8 p. m. at 29.97. The wind in the meanwhile was going round through north to northeast, from which point it was blowing on the morning of Sunday the 29th, when the barometer at 8 a. m. stood at 30.00. On Sunday morning we had the regular trade-wind sky, and the last traces of the disturbance (including the swell on our reef at Christiansted) had disappeared.

The return of the trade wind to the area which had so recently been disturbed brought, however, a welcome fall of rain, measuring from 1.00 inch to 2.50 inches in the different parts of the island.

Readings of the barometer at 8 a. m.

Sunday, November 22	30.02
Monday, November 23	29.97
Tuesday, November 24	29.87
Wednesday, November 25 *	29.82
Thursday, November 26	29.86
Friday, November 27	(Not noted.)
Saturday, November 28	29.90
Sunday, November 29	30.00

* Lowest noted 29.73 at 3:25 a. m.

We give the successive morning readings of the barometer for the week in the table above, and it will be noted that the rise has occupied a longer time than the fall.

It is, of course, impossible with the data at hand to trace the course of the disturbance accurately, but we believe it will be found to have come from the Caribbean to the south of Santo Domingo, or thereabouts, and to have advanced from about west-southwest to east-northeast. The rate of movement has been very slow, probably not more than 7 miles an hour[1] during its approach to St. Thomas and less even than that afterwards. The Weather Bureau stations at Santo Domingo and San Juan will doubtless be able to tell on what side of each of these places the disturbance passed. Possibly it was north of both, but more likely it passed south of Santo Domingo and north of San Juan. It may be that we ought not to rely fully on the indication of the cirrus plumes on the morning of the 22d, but if we do, they indicate the then position of the center as south of Santo Domingo, or on that line, and the distance from St. Thomas was probably between 400 and 500 miles. That the direction of the center was about as indicated is further confirmed by the fact that the lower clouds on Monday afternoon were moving from south-southeast, the surface wind being from east-southeast. The falling barometer showed that the movement was drawing nearer to St. Thomas, and the shift of wind during Tuesday night, taken with the fact that the lowest barometer noted was also at that time, shows that the center was then passing on the north side of St. Thomas. It is likely that it was not far away (much less than a hundred miles probably), which may be inferred from the rapid shifting of the wind during Tuesday night, in spite of the obviously slow movement of the center. Note in this connection that the surface wind between Monday afternoon and Tuesday morning went round from east-southeast to south-southeast (say 4 points in about fifteen hours), whereas, between Tuesday morning and Wednesday morning it went round from south-southeast to about west (say 10 points in about twenty-four hours).

There could have been no hurricane around the cyclone's center, or we would have heard of it from the west, moreover, the steamer *Caribbee* passed in front of it on Tuesday, and on arriving at St. Thomas on Wednesday morning reported only head winds.

It is worth noting that a very similar movement occurred two years ago in the early days of November, 1901. Then also the depression moved up against the trade wind, was attended by considerable calms while the air was moving from the west, and was accompanied by much thunder and lightning. In all these respects, as well as in having no hurricane center, that movement closely resembled the recent one. It differed from it, however, in giving a much larger quantity of rain.

We are indebted to Captain Dix of the R. M. S. *Solent* for the following interesting account, dated November 26, of the cyclone which passed south of Antigua on the 24th instant.—*St. Thomas Tidende.*

I first experienced the effects of it on Tuesday night at Roseau when a heavy southerly sea came in, and it was with much difficulty that I managed to land my cargo, etc. I left Roseau at 9 p. m., and on approaching Guadeloupe the weather became very stormy and the barometer fell to 29.78, and at Basseterre the sea was running so high that I found it absolutely impossible, and in fact dangerous, to attempt landing anything; however, I sent my mail boat in with the mails, but the officer returned reporting that the seas were breaking clean over the wharf, and he could not land them, so I proceeded, overcarrying several passengers and the mails. On the way to Montserrat we had all the shifts of the wind from east through south to south-southwest. I concluded that the storm was south of us and traveling to the westward.

I arrived at Montserrat at 6:45 a. m. 25th instant; weather very stormy, with terrific squalls of wind and rain, sea running very high. I dared not attempt to anchor. I waited off the port and a boat managed to come off, and I threw the mails into it and proceeded for Antigua, experienced terrific squalls with heavy rain all the way, but in the harbor of St. Johns the sea was moderately smooth. At Nevis also I had a little shelter from the southward and landed cargo and mails.

I arrived at St. Kitts at 11 p. m. and found the sea running very high, with heavy showers and continuous thunder and lightning. I received a letter from our agent, Mr. Horsford, saying it would be impossible to land any cargo, two of his lighters had been smashed to bits on Tuesday night, and several boats were swamped during the day; the customs boat was capsized and one man drowned. I managed with much difficulty to land the mails in my own boat. I left St. Kitts at 1:30 a. m. to-day, and the weather and sea gradually moderated as I approached these islands.

From Captain Dix's narrative it will be seen that the *Solent* on her passage from Guadeloupe to Montserrat, early on the morning of Wednesday, the 25th ultimo, passed through a complete, though very small, cyclone. It was what we might call a "subordinate cyclone"—that is to say, a smaller movement within the area of the larger. If the reader will draw a circle and will first mark the ship's position when the wind came from the east—that is to say, at the top of the circle; next mark it when the wind was from south-southwest—that is to say, on the right-hand of the circle something more than halfway down; lastly, will join these two points by a straight line, and mark in that line the ship's position when the wind was from the south—that is to say, on the right of the circle's center, the diagram will show him that the cyclone passed the steamer with its center on the western side and moving about northwest. It must have been moving rather fast, too, for the steamer was herself moving in about that direction, yet was passed by the cyclone. That this cyclone was not the main movement is plain from this consideration alone: that while these changes of wind were going on between Guadeloupe and Montserrat the wind was blowing hard from about south at Basseterre St. Kitts, to the northwest of the ship's position, and had been so blowing all Tuesday night. The *Solent's* experience explains the telegram from Antigua about a cyclone center to the south of that island, which at first looked meaningless in view of the wider facts. Such small whirls within the larger whirl are not altogether unknown. It seems likely that such a "subordinate cyclone" was met by the cable steamer *Henry Holmes* in the channel between St. Croix and St. Thomas on the night of the 21st

[1] The rate of the forward motion given in the above article is got in this way: If we assume that on Sunday morning the 22d (say at 6 a. m.) when the cirrus clouds were so abundant from west by south, the center was 450 miles away, then the time to 3 a. m. on Wednesday the 25th (about the time the center was passing St. Thomas on the north) is 69 hours, which divided into the 450 miles gives a little over 6½ miles an hour; if we take the distance as 500 miles we get about 7 miles an hour. It is probable that the latter distance assumed is not too great, for we now know that on Tuesday night the disturbance was well marked at Dominica, say over 300 miles from the position of the center at that time. How much farther to the southeast it made itself felt in a less degree we have no means at present of knowing; but it would not surprise us to hear that the barometer at Barbados (150 miles farther on) also showed its influence.

of October, during the passage of an extensive depression on the west side of the Danish Islands and moving to the northwest. The wind from west-northwest that blew at Frederiksted from 10 to 1 that night and did some damage to the small craft there, was probably a part of that minor movement.

The details given in Captain Dix's notes are very interesting and they show that the stormy weather struck the several islands from St. Kitts to Dominica *about the same time*. If we run a line out from the assumed position of the cyclone's center on Tuesday night at right angles to its track and going south-southeast, we shall find that it passed west of the islands, which will lie, roughly speaking, parallel to it. It seems that the whole southeast quadrant of the cyclone was stormy, but was most so in the neighborhood of that line, on the passing of which all of the islands affected were, in fact, at about their nearest to the center. After that had passed and the southwest quadrant was entered, the wind, though maintaining its cyclonic movement, fell to mild westerly breezes. Why it did so is an interesting speculation, but here we only note the fact. Later on information from the different islands may throw further light on the whole subject, but we think that, in the main, the theory given above in our article will be sustained.

POPULAR ARTICLES REQUESTED.

It is doubtless known to many of our readers that the beautiful magazine, St. Nicholas for Young Folks, has for several years devoted a few pages to a department of nature and science, in which occasionally we find something bearing on the weather or the atmosphere. The editor has recently appealed to us for further contributions "on some weather phenomenon of instruction and entertainment to young folks." A similar request has also been received from the editor of the Youths' Companion. We believe we can not do better for the general cause of meteorology than to urge that those who are gifted in writing such sprightly articles as are acceptable to these magazines send their efforts to the St. Nicholas Magazine, Century Company, Union Square, New York City, or to The Youths' Companion, Boston, Mass., so as to make sure that meteorology and its interesting atmospheric phenomena are brought home to the attention of their readers.

BLACK RAIN IN CLERMONT COUNTY, OHIO, AUGUST 19, 1903.

Mr. J. Warren Smith, Section Director, Columbus, Ohio, has forwarded some samples of black rain, collected by Dr. Julius D. Abbott, of Bethel, Ohio, which fell on August 19, 1903, and was the third black rain that had occurred this year. Dr. Abbott says that the creeks and even the furrows in the fields were full of this black water, but the sample that he sends the Weather Bureau was taken out of a perfectly clean porcelain kettle. He states that the black coloring substance does not settle but gives the water a permanent inky appearance. It leaves a black scum on the creek banks and on the grass. A similar description of the rain was received from Daniel Bohl, at Laurel, Clermont County, Ohio.

Samples of the dust from black rains have often been examined microscopically and chemically. An elaborate report of this kind will be found in the MONTHLY WEATHER REVIEW for January, 1895. It seemed likely that a physical examination of the dust and a determination of the size of the particles would be especially interesting in the present case, as Dr. Abbott's sample evidently represented the finest dust of which the great beds of loess are formed. The sample was, therefore, sent to Prof. Milton Whitney, Chief of the Bureau of Soils, who reports as follows:

The material in suspension was found to be completely floculated when the sample was received and would soon settle to the bottom of the vial, even after being violently agitated. The addition of a small amount of ammonia to a part of the sample served to break the floculation, and a microscopic examination of this material showed that it was, for the most part, exceedingly fine, many of the particles being less than one-thousandth of a millimeter in diameter. There were, however, a few transparent crystalline particles which were probably quartz. The vial when first opened emitted a strong odor of hydrogen sulphide. This fact, together with the microscopic examination, leads me to believe that the material is probably extremely fine soil with a considerable portion of organic matter, as Mr. Smith has suggested.

The explanation offered by Mr. Smith is as follows:

These two places are in southern Clermont County, east of a long bend in the Ohio River. I shall be glad to know whether my theory that this "black rain" is the dust blown up in the outrushing squall in advance of the thunderstorm is considered a satisfactory one. The Ohio River must be low at this point and the long drought must have dried the black mud deposit on the river banks into dust so that it would be easily blown high into the air, to be deposited 15 or 20 miles to the east."

We see no reason to doubt the general correctness of Mr. Smith's explanation.

VERTICAL COMPONENTS OF ATMOSPHERIC MOTIONS.

The following passage occurs in a sentence lately examined by the Editor:

The cold, dry air, going off in all directions during a cold wave is not alone due to the temperature of the subarctic regions translated eastward and southward by the general circulation, but equally to the vortical action that is going on within the great anticyclone; a process whereby the cold of the upper air levels is brought down, proving a potent factor in augmenting the cold conditions of the lower strata.

The preceding sentence seems to imply that the cold air of the higher levels, when brought down to the earth's surface, retains its low temperature and augments the cold already prevailing in the lower strata. Does not this simple theory require careful examination? We have actual observations of the temperature of the upper air that give us something like a reliable basis for a computation on this matter. We copy from the MONTHLY WEATHER REVIEW for April, 1901, page 177, the following table, showing the mean temperatures by months, at high altitudes, on days when observations could be obtained by Leon Teisserenc de Bort, at Trappes, near Paris, by means of sounding balloons during 1898, 1899, and 1900:

TABLE 1.—*Mean temperatures.*

Month.	Paris.			Winnipeg.	
	On the ground.	At 5000 meters.	At 10,000 meters.	On the ground.	At 10,000 meters.
	° C.	° C.	° C.	° C.	° C.
January	5.4	—15.3	—47.6	—21	—74
February	1.0	—21.8	—53.4	—19	—73
March	0.9	—20.9	—53.7	—10	—65
April	5.3	—18.4	—49.3	3	—52
May	7.0	—16.8	—51.3	11	—47
June	14.2	— 8.8	—45.3	17	—42
July	15.7	— 8.7	—44.5	20	—40
August	17.8	— 7.2	—41.8	18	—42
September	13.4	— 9.7	—47.9	12	—49
October	10.2	—11.0	—45.1	4.5	—50
November	3.8	—12.8	—45.2	— 6.5	—55
December	0.9	—18.9	—52.4	—16	—69

It will be seen from this table for the latitude of Paris (which is about 48° 15′ north, and corresponds with the latitude of Manitoba), that on these special days the air at 10,000 meters altitude has, for instance, in March, an average temperature of —53.7° C., but of 0.9° at sea level. Now, the charts of mean monthly isotherms for North America give —10° C. for sea level at Winnipeg, in Manitoba, at about the same latitude and other temperatures as shown in the 5th column of Table 1. But these latter figures represent the average of the whole month and not of any special days, such as those on which balloon ascensions can be made; doubtless the averages for balloon work at Winnipeg would be higher than these, because the coldest weather is unfavorable for such work. However, the Paris observations give us a basis for estimating the rate of decrease of temperature with altitude, thus, in March, the temperature at 10,000 meters is 52.8° C. below that at the ground. If we apply the similar differences month by month to Winnipeg we get some idea as to what the average temperature may be at 10,000 meters above Manitoba, and the result is given in the last column of Table 1.

Now, the above explanation of the origin of the cold air in a